Space Weather Technical Forecast

Issued on Wednesday, 12 January 2022 at 13:02 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of G1/Minor Storms day 4 (15th).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was Very Low in the last 24 hours, with only one long-period B9-flare, originating from over the northeast limb. This produced a coronal mass ejection (CME) which was seen to be far-sided in coronagraph imagery. There are currently five sunspot regions on the visible disc. Three of these are mature features, with the largest AR2924, Fhi/Beta in the southwest, which has shown some growth, but generally has been inactive. AR2925 and AR297 are both small remnant Hsx/alpha regions in the southern hemisphere. AR2926 Cri/Beta in the northwest quadrant has shown some small reemergence of spots but remains a very small and simple region. A newly unnumbered region has developed north of AR2925, which is currently very small and simple, but will need watching for any further development. No Earth-directed CMEs have been observed in available imagery.

Solar Wind / Geomagnetic Activity: Solar wind speed as observed by DSCOVR at L1 has eased from slightly elevated levels of peak 418 km/s to background levels at around 370 km/s.The density of the wind was at or below average. Total interplanetary magnetic field (IMF) strength, Bt, was mainly weak, peaking 8nT, with the Bz component also varying weakly between -4 and +6 nT. Phi angle was predominantly negative (towards the Sun). Geomagnetic activity was Quiet (Kp0-2).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) remained at Background levels throughout. High energy electron flux (greater than 2MeV) was at background levels throughout. Electron fluence remained steady and well below the Active threshold (1e8 integrated pfu), with 1.29e6 integrated pfu recorded at 12/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be Low to Very Low. There is an increasing, but still slight chance, of this increasing to Moderate by day 4 (15th) as far-sided regions approach or move around the eastern limb.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs. Background solar winds are expected to persist until the arrival of the fast winds of coronal hole 44. This is most likely to occur on day 4 (15th). Mainly Quiet geomagnetic activity until this arrival, becoming Unsettled to Active with a chance of G1/Minor Storm intervals thereafter.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is forecast to remain at background levels. The high energy electron flux (greater than 2MeV) is likely to increase through this period, perhaps reaching high levels on days 2 and 3 (13-14 January). Electron fluence is expected to remain below the Active (1e8 integrated pfu) threshold, but with a rising trend later in the period.

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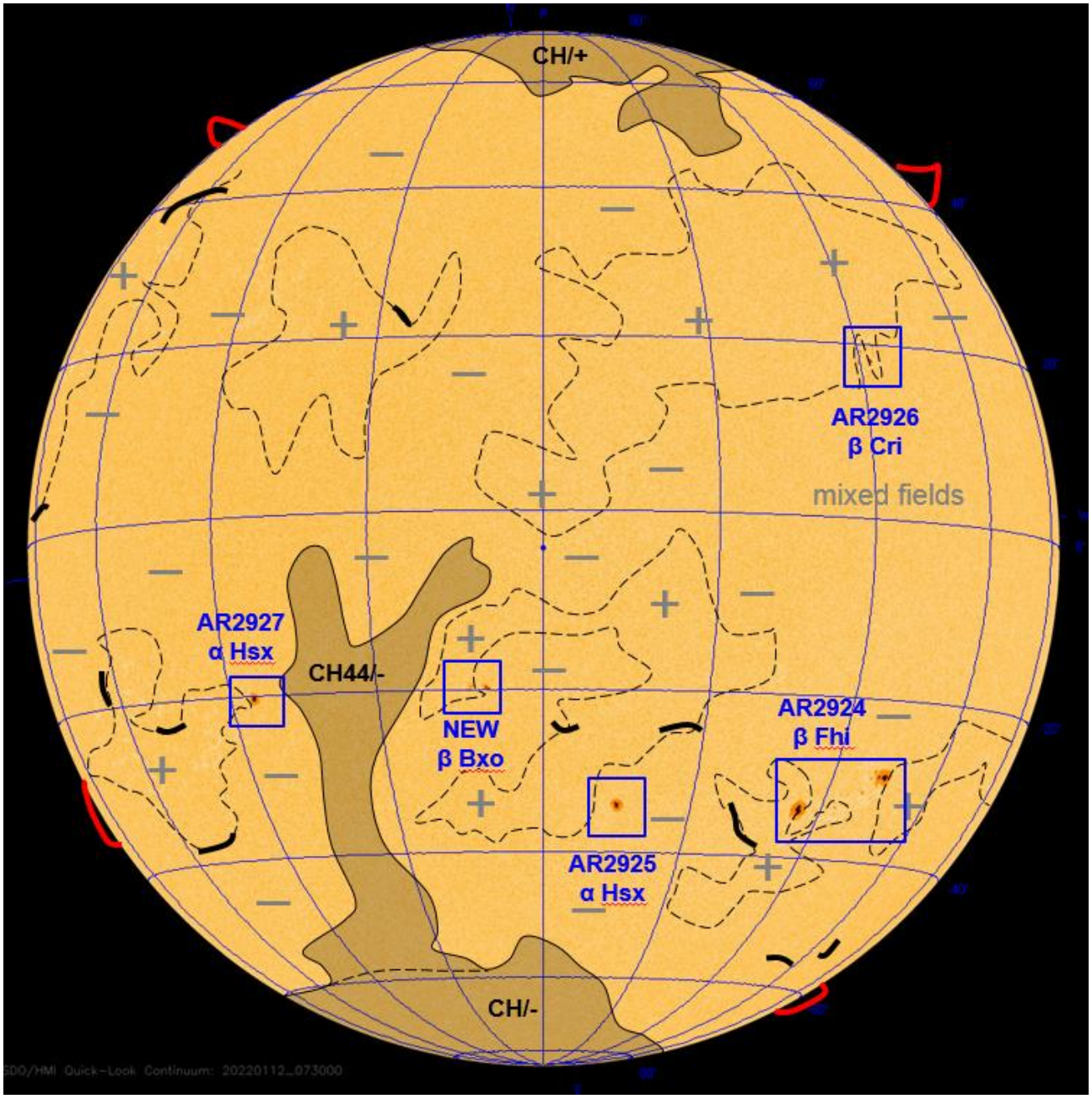
Figure 1. Solar Analysis Valid 12/0730UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are no Earth-directed CMEs.

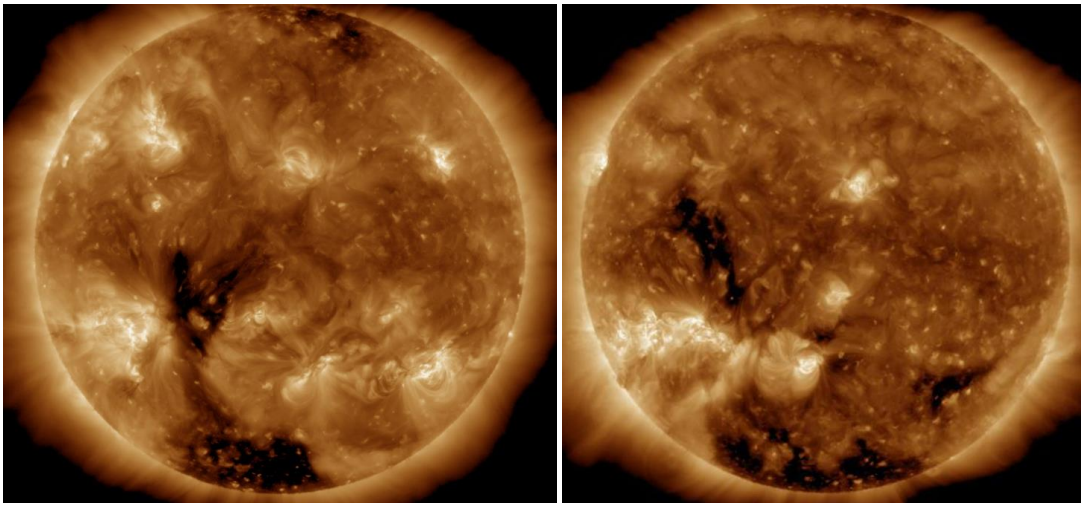
Current background solar winds are expected to persist for much of the period. The arrival of the fast wind of coronal hole 44 is anticipated during day 4 (15th), with some uncertainty in the exact arrival time on the day. Enlil is currently providing poor guidance, suggesting arrival on the 13th, with persistence indicating an enhancement on the 15th. Uncertainty stems from the structure of the coronal hole on this rotation, which appears to be larger and more potent, and connected to the southern crown coronal hole. The northern portion is slightly more advanced on this rotation. With potential solar winds exceeding 600km/s, arrival is most likely on the 15th. Geomagnetic activity is expected to be Quiet until the arrival of the fast wind, most likely on day 4 (15th). Activity is then expected to become Unsettled to Active, with a chance of G1/Minor Storm intervals.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	5	30
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

Figure 2: SDO AIA-193 of previous rotation (left) and current rotation (right), which shows a different coronal hole structure.



Radio Blackouts - X-Ray Flares:

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Solar activity is currently Very Low, with one long-period B9-flare in the last 24 hours, probably originating from ex-2921 over the northeast limb, which has produced a far-sided CME seen in coronagraph imagery.

There are currently five sunspot regions on the visible disc. AR2924 is the largest, and has generally been inactive. However, some growth in small intermediate spots has been observed in the last several hours, alongside further slight spreading of the main spots, currently classified as Fhi/Beta, with a slightly increased flare potential. AR2926 has also continued to very slowly develop, but remains small and simple. AR2925 and AR2927 are both small, simple and inactive mature spots. A new unnumbered region that has developed north of AR2925 is currently very small and simple, but will need watching for any further development. There are also two large areas of plage in the northeast and southeast disc.

Solar activity is expected to be Very Low to Low at first, with a only a daily slight (10%) chance of M-flares, up to day 3 (14th).

There are two notable regions, visible on far-side products, perhaps corresponding to ex-2915 and ex-2918 from the previous rotation. The former is due over the limb during day 3 (14th), whilst the former has a much stronger far-side signal and is expected on the 16th, although any flaring from this region would potentially be observable by day 4 (15th). Consequently the M-flare risk is gradually increased to 20% by day 4.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	10	10	10	20
Very Active	R3 to R5 X Class	No	1	1	2	2

Figure 3: Solar wind persistence model - Enhancement on 15th coincides with expected rise from current CH, but some notable uncertainty.

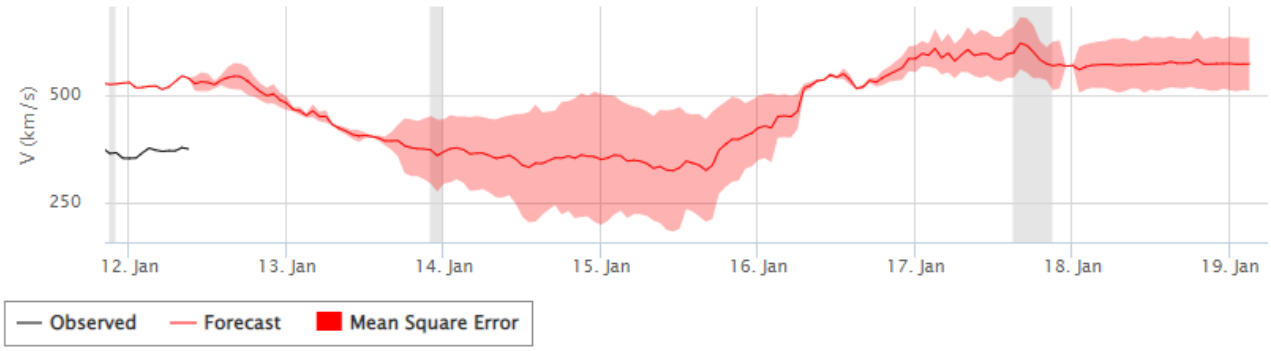

Figure 4: Met Office Enlil Model – shows enhancement on the 13th much earlier than persistence or present CH position indicates.

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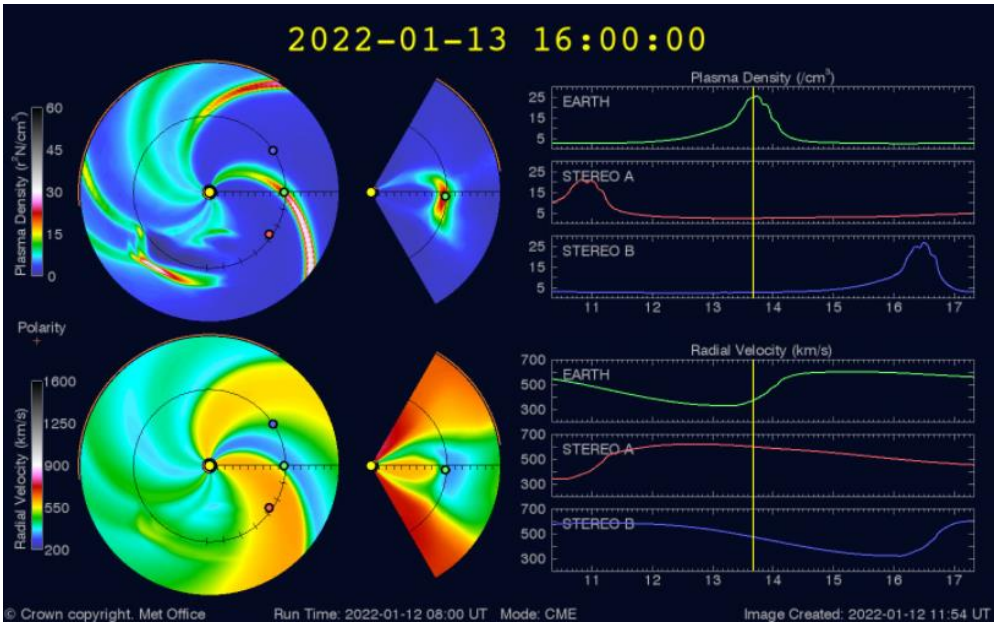


Figure 5: Bartels Kp music plots, shows observed G1/minor storm on previous rotation.

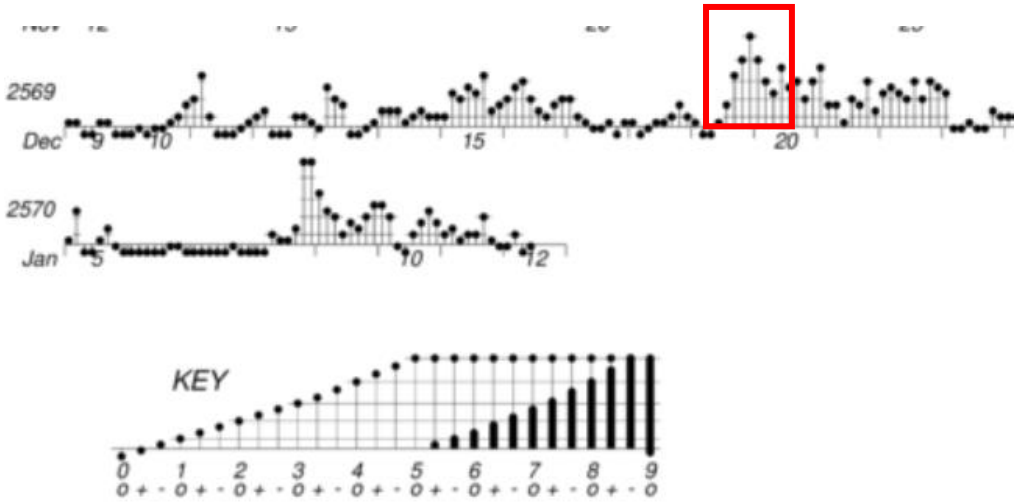
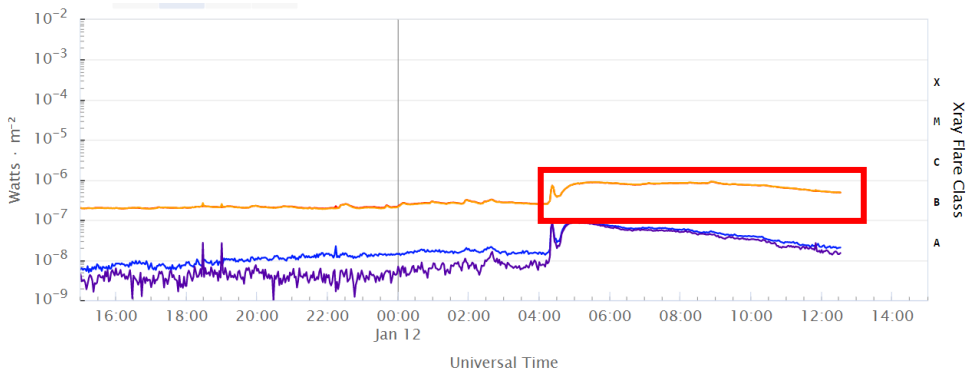


Figure 6: GOES-16/17 X-Ray Flux – shows impulsive B9 flare originating from over the northeast limb, which can be seen in the SDO AIA 304 and STEREO-A EUVI 195 images (see below).



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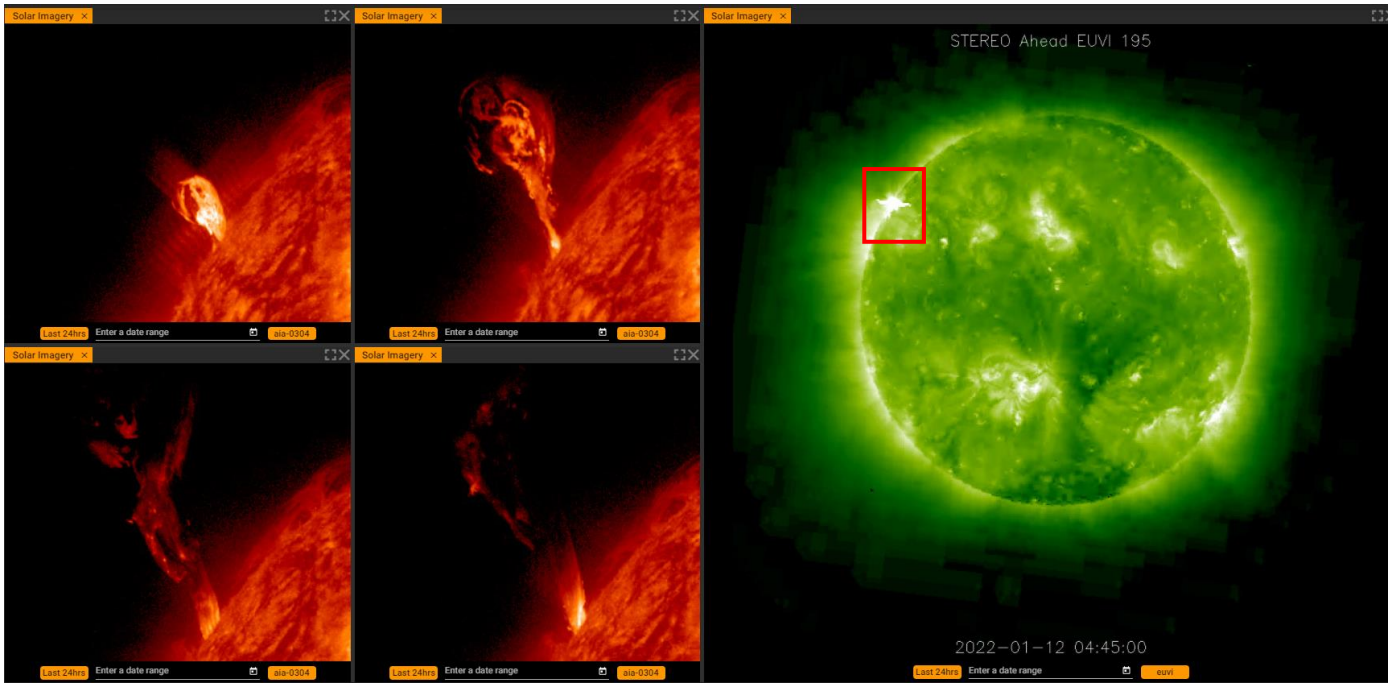
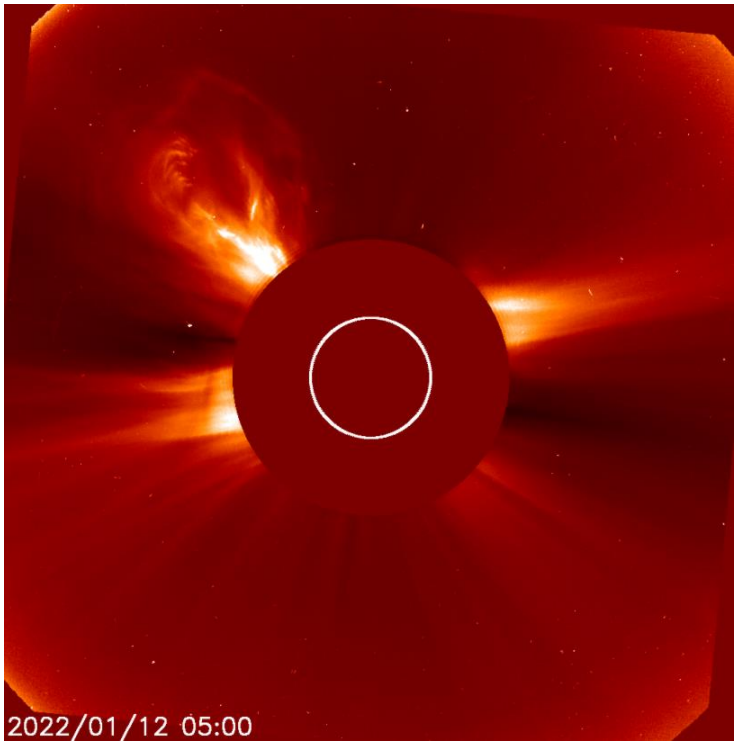


Figure 7: LASCO-C2 shows far-sided CME – not Earth-directed.



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as observed by GOES-16 is currently at background levels and will most likely persist at this level in the absence of solar activity.

Radiation Storms	Level (cm^{-2}	Past 24 Hours	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)

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Probability (Exceedance)	$sr^{-1} s^{-1}$)	(Yes/No)	(%)	(%)	(%)	(%)
Active	≥ S1	No	1	1	1	1
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

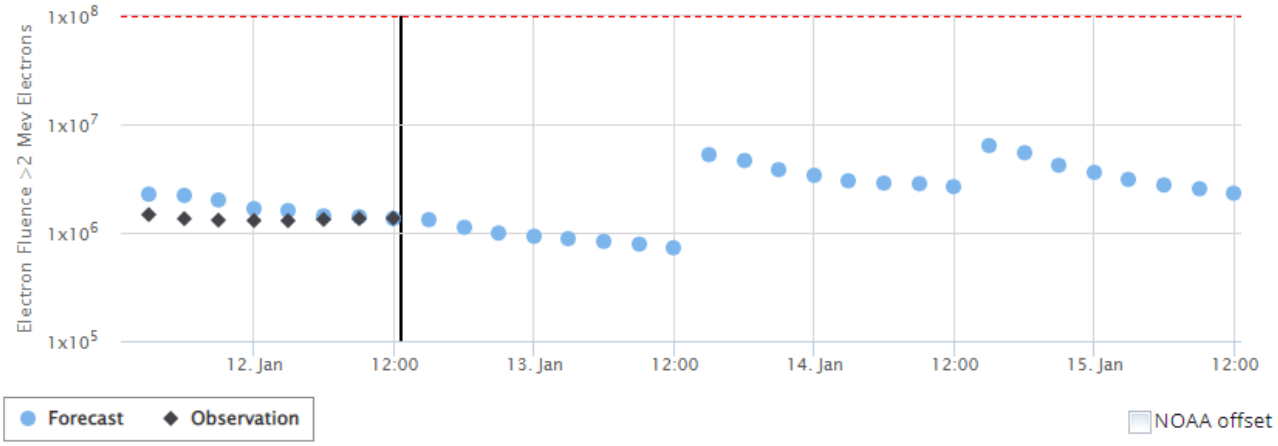
High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2MeV) as observed by GOES-16 has been at background levels. Despite recent solar wind enhancement from the fast wind of CH43, there has been little sign of the electron population increasing as winds ease. There is still a chance of some moderate flux occurring through the period, however it looks likely that levels will remain below the alert level (1000 pfu).

The associated 24 hour electron fluence is below the Active threshold and expected to persist at this level, although a slight increasing trend is possible. This is supported by REFM, which is currently giving good guidance.

GEO Electron Environment	Level ($cm^{-2} sr^{-1} day^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	1	1	1
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 8: GOES-16 >2MeV Electron Fluence with REFM



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